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Heart rate variability (HRV) of male subjects related to oral reports of affective pictures

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Abstract

This study is a replicate study with male subjects of our previous experiment with 25 female subjects. We measured HRV in 14 males while they were viewing 16 unpleasant, 16 neutral, and 16 pleasant International Affective Picture System (IAPS) PowerPoint slides. Spectral analysis was performed on the data using the fast Fourier transform to extract powers of the spectral components relating to sympathetic and parasympathetic activity. The preliminary results show that in the reporting phase sympathetic activity is significantly lower ($p<.05$) during unpleasant pictures than during pleasant pictures. The results of male data show that unpleasant pictures produce a much lower sympathetic response in the evaluating and in the reporting phase than in the viewing phase. In the reporting phase, indication of lower sympathetic activity was found during unpleasant pictures than during pleasant pictures.

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1. Introduction

Earlier studies show that emotions are capable of being elicited quickly, effortlessly and subconsciously upon exposure to a relevant stimulus (Cacioppo et al. 2000). A human is limited by the level of awareness and by language when describing emotions accurately. More reliable indicators of emotion can be found in the central nervous system and in the autonomic nervous system. Stressors are associated with increased sympathetic activity, decreased parasympathetic activity and anxiety, and depression is associated with an overall decrease in parasympathetic activity (Berntson & Cacioppo 2004). Overall parasympathetic activity is associated with enhanced attention, effective emotion regulation and responsivity (Friedman & Thayer 1998).

Our earlier findings showed that in female subjects, unpleasant pictures produce a higher sympathetic response than neutral and pleasant pictures (Rantanen et al. 2010). Further, the intensity of a sympathetic response decreased

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in the report phase after viewing an unpleasant picture. However, after neutral and pleasant pictures no decrease in the intensity of a sympathetic response was detected. In the female subjects, an unpleasant stimulus produced a strong emotional response during the picture viewing phase and a mild response during the report phase. A pleasant and neutral stimulus produced mild emotional response during the picture viewing phase and a strong response during the report phase. This study is a replicate study with male subjects of our previous experiment with 25 female subjects. The aim of this study was to explore autonomic activity of male subjects during pleasant, neutral and unpleasant pictures while viewing, evaluating and reporting. Beat to beat interval was measured and HRV –analysis was used to obtain measures for sympathetic and parasympathetic activity. The main interests were the differences in HRV between pleasant, neutral and unpleasant pictures in different phases and differences between the phases during pleasant, neutral and unpleasant pictures. A further interest was to explore if the phenomena found in female subjects would show also in male subjects.

2. Method

2.1. Participants

A total of 14 right-handed, Finnish speaking (native fluency in Finnish and no reported history of speech disorder), undergraduate male students from the University of Oulu participated in the experiment. The students participated voluntarily in the experiment during their studies. Eyesight was tested using the Snellen card, and anxiety was measured using the State Trait Anxiety Inventory (STAI) (Spielberger et al. 1970). In addition, possible alexithymia was tested with TAS-20 (Bagby et al. 1994), the validity of which has also been tested in Finland (Joukamaa et al. 2001). All subjects had normal eyesight (≥ 1.0), and no anxiety (STAI score < 35) nor alexithymia (TAS-20 score < 51) was found. After the explanation of the experimental protocol, the subjects gave written consent.

2.2. Apparatus

The IAPS pictures (International Affective Picture System) (Lang et al. 2005) were presented on the screen (17”) of a computer with an Intel Pentium 4 processor which was connected to a Tobii 1750 eye tracking system (Tobii Technologies AB, Sweden). The sample rate was 50 Hz, and the spatial resolution was 0.25 degrees. The eye tracking system located every fixation point and measured the duration of fixation, the pupil size variation and the distance of the eye from the computer screen. The heart rate variations were measured using beat-to-beat RR-intervals with a Polar S810i heart rate monitoring system (Polar Oy, Finland). The facial expressions were recorded with an IEEE 1394 Firewire camera (Sony DFW-VL500, Japan). In addition, the subject’s speech was recorded using a wireless microphone system (Sennheiser HSP2, Denmark)

2.3. Materials

A total number of 48 International Affective Pictures (Lang et al. 2005) were used in the experiment[1]. The pictures were divided into three different groups; 16 pleasant, 16 neutral and 16 unpleasant pictures. The overall luminance levels of the pictures were adjusted with Adobe Photoshop 6.0 software.

2.4. Procedure

[1] The number of the IAPS pictures used in the experiment were: pleasant (2050, 2057, 2070, 2091, 2165, 2209, 2216, 2340, 2352, 2550, 4608, 4601, 4653, 4700, 8490 and 2040); neutral (2190, 2191, 2215, 2235, 2393, 2487, 2516, 2745, 2840, 2850, 2870, 7493, 7496, 7550, 8311 and 9070); unpleasant (2375, 2750, 2800, 2900, 3015, 3051, 3181, 3301, 3550, 6243, 6570, 6838, 9040, 9421, 9435 and 2095).

The subjects were interviewed and STAI (Form 2) and TAS-20 questionnaires were presented before the experiment. Subsequently, the subject was able to practice the experimental procedure from “the paper version” with the experimenter. Thereafter, the subject practiced the procedure with the computer. Before the actual experiment, the subject rested for 60 secs, while the heart rate monitoring system, audio and camera systems were combined with the eye tracking system. The subject’s eye movements were also calibrated into the eye tracking system.

In the experiment, the pictures were presented on the computer screen and the distance of the subject from the screen was 65 cm. At first, the subject had to look at the letter X, which appeared in the middle of the screen, about 30 secs. Sequentially either a pleasant or neutral or unpleasant picture appeared on the screen for 20 sizes in random order. Immediately after the 20 secs, the SAM scale (Self-Assessment Manikin) (Lang et al. 2005) appeared. The subject’s task was to orally report the valence and arousal of the picture according to the SAM scale (1-9 categories). These categories were grouped according to their valence giving new categories: “pleasant” (1-3), “neutral” (4-6), and “unpleasant” (7-9). This grouping was made in order to improve comparison with IAPS pictures (pleasant, neutral and, unpleasant pictures).

After the report, the subject had to press the enter button in order to darken the screen. In this phase, the subject’s task was to oral report to the experimenter, who was sitting behind the computer screen, on what had been seen, what was happening and what was going to happen in the picture. After the report, the subject had to press the enter button for the next picture to appear. After 48 pictures, the letter X appeared for 30 secs. Finally, the STAI (Form 1) questionnaire was presented. The experimentation was approved by the Ethics Committee of the Faculty of Education, University of Oulu.

2.5. Heart functioning and emotions

Resting heart rate varies widely in different individuals due to physiological stresses like exercise, and is also dependent on physical fitness and age related factors (Hainsworth 1995). Heart rate is normally determined by the rate of depolarization of the cardiac pacemaker. In a healthy individual, the heart rate represents the net effect of parasympathetic and sympathetic nerves. Mostly parasympathetic or vagal stimulation slows the heart rate, but small stimulation may cause an increase in the heart rate. Increased activity in sympathetic nerves causes an increase in HR (Hainsworth 1995).

There are many reflexes influencing heart functioning. Bradycardia is caused by stimulation of baroreceptors, carotid chemoreceptors, coronary chemoreflex and lung hyperinflation (Hainsworth 1995). Tachycardia is caused by stimulations of atrial receptors, aortic chemoreceptors, muscle receptors and moderate lung inflation (Hainsworth 1995). Also respiratory influences have an effect on HR. The sinus arrhythmia (RSA) refers to variation in HR due to respiration. Generally HR increases during inhaling and decreases during exhaling (Jorna 1992; Ahmed et al. 1982). Further, there is strong evidence that speech has a decreasing effect on the inhaling/exhaling ratio which results as an increase in sympathetic activity.

2.6. Data analysis

The obtained RR –data were examined for abnormal beats and artifacts found were removed. HRV analysis was executed using HRV Analysis software (University of Kuopio, Finland). Spectral analysis was performed on the data using the fast Fourier transform to extract powers of the spectral components relating to sympathetic and parasympathetic activity per subject in each condition. Paired t-tests with Bonferroni corrections were used to compare differences between the phases and the pictures.

Spectral analysis of the HRV signal is usually performed on stationary records of at least 200-500 consecutive heart beats (Cerutti et al. 1995). This range is chosen to obtain sufficient frequency resolution and the stationary condition. The classical frequency analysis is based on the Fourier transform which can be evaluated through the FFT algorithm (Cerutti et al. 1995).

The PSD shows three essential frequency ranges contributing to the total power. Long period rhythms are found at very low low-frequency (VLF, 0-0.04 Hz). VLF accounts for long-term regulation, probably related to thermoregulation, the renin angiotensin system and other humoral systems (Cerutti et al. 1995). The low frequency rhythms (LF, 0.04-0.15) are usually found around 0.1 Hz. Both sympathetic and parasympathetic activities may be involved, but an increase in LF is mostly considered to be related to a sympathetic effect (Cerutti et al. 1995). The high frequency rhythms (HF, 0.15-0.4) are related to breathing activity mediated by the vagus nerve. It is therefore generally accepted as an indicator of parasympathetic activity (Cerutti et al. 1995). The LF/HF ratio is used for measuring autonomic balance considering the overall activity of the sympathetic and parasympathetic nervous system.

3. Results

According to the results there was a significant decrease in the LF / HF ratio of the picture viewing phase (M=2. 59, SD=1. 85) to the evaluation phase (M=1. 46, SD=0. 96), at (13) = 2.76, P<. 05 and to the report phase (M=1. 92, SD=1. 59), at (13) = 2.75, P< .05, during unpleasant pictures. During neutral pictures, there were no significant differences between the phases. During pleasant pictures LF/HF ratio was significantly lower during the evaluation phase (M=1. 36, SD=1. 51) than in the picture viewing phase (M=2. 68, SD=1. 97) at (13) = 2.79, P<. 05, and in the reporting phase (M=2. 18, SD=1. 50), at (13) = -2.45, P<. 05. Furthermore, in the viewing phase LF/HF ratio was higher during pleasant pictures (M=2.68, SD=1.97) than during unpleasant (M=2.59, SD= 1.85) and neutral (M=2.06, SD= 1.58) pictures but the differences were not statistically significant. In the evaluation phase LF/HF ratio was higher during unpleasant pictures (M=1.45, SD=1.01) than in neutral pictures (M=1.22, SD=0.63) and pleasant pictures (M=1.36, SD= 1.51) but the differences were not statistically significant. In the report phase LF/HF ratio was lower during unpleasant pictures (M=1.92, SD= 1.59) than during neutral (M=1.98, SD= 1.82) and pleasant pictures (M=2.18, SD= 1.50) but the differences were not statistically significant.

4. Conclusion

The results of male data indicate that unpleasant pictures produce a lower sympathetic response in the evaluating and in the reporting phase than in the viewing phase. No statistically significant differences were found between pleasant, neutral and unpleasant pictures during viewing, evaluation or the reporting phase, though in the female data from our earlier experiment a clear difference was found between pleasant and unpleasant pictures in the viewing phase. Male subjects appear to be less responsive to unpleasant stimuli. Still, some differences in the male subjects were found in the reporting phase, indicating a lower sympathetic response in the reporting of unpleasant pictures. The reporting of an unpleasant stimulus produces a low emotional response and reporting of a pleasant stimulus produces a stronger emotional response. In female subjects we found that talking about high-response experience is calming, and talking about a low-response experience is accelerating. Findings from male subjects are consistent with these earlier findings.

Despite the differences in the results between female and male subjects, the results support our hypothesis that the subject's strategic plan determines the emotional response in the reporting phase. The subject's strategic plan is comprised of the whole experimental task (view the pictures, evaluate, and report them). Pleasant pictures produce a lower sympathetic response than unpleasant pictures while viewing, but higher response while reporting the pictures. It seems that there is a difference in the emotional organization of the subjects between the pictures. Unpleasant pictures produce a stronger emotional experience and emotion processing is emphasized. Emotional processing is shown as a decrease in the LF/HF while reporting of unpleasant pictures. Pleasant and neutral pictures produce less emotional experience, and the task orientation is emphasized. Task related stress is shown as an increase in LF/HF while reporting.

It should be noted that the effect of breathing and speech on HRV were not observed in this study. This may produce effects on HRV, especially an increase in LF due to respiratory influences. Exhalation slows, and inhalation accelerates the HR. Talking is shown to increase LF, and this should result as an additional increase in the LF/HF ratio (Beda et al. 2007). Despite this increasing effect on LF, the difference in HRV between the picture viewing phase and the report phase is evident during unpleasant pictures.

References

Ahmed, A.K., Harness, J.B., Mearns, A.J. (1982). Respiratory control of heart rate. *European journal of applied psychology* 50, 95-104.

Bagby, M., Parker, J., and Taylor, G. (1994). The Twenty-Item Toronto Alexithymia Scale-I. Item selection and cross-validation of the factor structure. *Journal of Psychosomatic Research* 38, 23-32.

Beda, A., Jandre, F.C., Philips, D.I.W., Giannella-neto, A., Simpson, D.M. (2007).Heart-rate and blood-pressure variability during psychophysiological tasks involving speech: Influence of respiration. *Psychophysiology* 44, 767-778.

Berntson, G. & Cacioppo, J. (2004). Heart rate variability: stress and psychiatric conditions. In Malik, M., Camm, J. (Eds.). *Dynamic electrocardiography*, pp.57-64. New York: Futura publishing company Inc.

Cacioppo, J., Klein, D., Berntson, G., & Hatfield, E. (2000). The psychophysiology of emotion. In Lewis, M., Haviland-Jones, J. (Eds.). *Handbook of emotions*, 2nd edition, pp. 173-191. New York: Guilford Press.

Cerutti, A. M., Bianchi, L. T., Mainardi, L. (1995). Spectral analysis of the heart rate variability signal. In Malik, M., Camm, J. (Eds.). *Heart rate variability*, pp. 63-74. New York: Futura publishing company Inc.

Friedman & Thayer. (1998). Autonomic balance revisited: Panic anxiety and heart rate variability. *Journal of psychosomatic research* 44 (1), 133-151.

Hainsworth, R. (1995). The control and physiological importance of heart rate. In Malik, M., Camm, J. (Eds.). *Heart rate variability*, 3-19. New York: Futura publishing company Inc.

Joukamaa, M., Miettunen, J., Kokkonen, P., Koskinen, M., Julkunen, J., Kauhanen, J., Jokelainen, J., Veijola, J., Läksy, K., and Järvelin, M.R. (2001). Psychometric properties of the Finnish 20-item Toronto Alexithymia Scale. *Nordic Journal of Psychiatry* 55, 123-7.

Jorna, P. G. A. M. (1992). Spectral analysis of heart rate and psychological state - A review of its validity as a workload index. *Biological psychology* 34, 237-257.

Lang, P.J., Bradley, M.M., and Cuthbert, B.N. (2005). International affective picture system (IAPS): Affective rating of pictures and instruction manual. Technical Report A-6. University of Florida, Gainesville, FL.

Rantanen, A., Laukka, S., Lehtihalmes, M. & Seppänen, T. (2010). Heart Rate Variability (HRV) reflecting from oral reports of negative experience. *Procedia of Social and Behavioral Sciences* 5, 483-487.

Spielberger, C.D., Gorsuch, R., and Lushene, R. (1970). The State-Trait Anxiety Inventory (STAI) test manual. Palo Alto, CA: Consulting Psychologists Press.